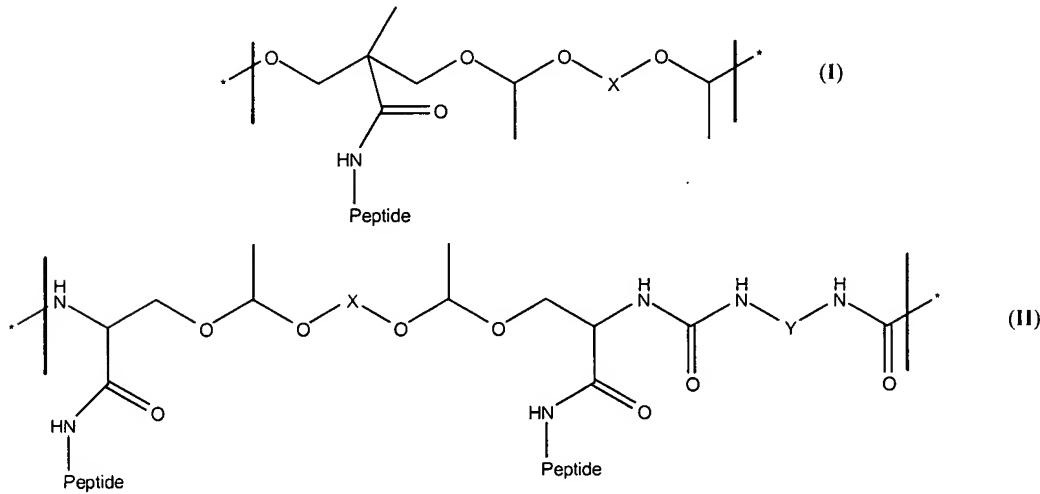


WHAT IS CLAIMED IS:

1. A complex for delivering a polynucleotide to a cell, comprising: (a) a polynucleotide and (b) a biodegradable polyacetal-peptide.
2. The complex of Claim 1 in which the polynucleotide is selected from the group of consisting of DNA and RNA.
3. The complex of Claim 1 in which the polynucleotide is selected from the group consisting of plasmid DNA, antisense, DNA oligomers, siRNA, ribozyme, and aptamer.
4. The complex of Claim 1 in which the peptide comprises 2 to 45 amino acids with at least one or more arginine or lysine amino acids from 20 biological amino acids.
5. The complex of Claim 1 in which the biodegradable polyacetal-peptide comprises at least one recurring unit represented by a formula selected from the group consisting of (I) and (II):



wherein the peptide is selected from any continuous combination of 2 to 45 amino acids with at least one or more arginine or lysine amino acids from 20 biological amino acids;

wherein X is selected from the group consisting of  $\text{CH}_2\text{CH}_2$ ,  $\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2$ ,  $\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2$ , and  $\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2\text{OCH}_2\text{CH}_2$ ; and

wherein Y is selected from the group consisting of linear or branched  $\text{C}_4\text{H}_8$ ,  $\text{C}_5\text{H}_{10}$ ,  $\text{C}_6\text{H}_{12}$ ,  $\text{C}_7\text{H}_{14}$ ,  $\text{C}_8\text{H}_{16}$ ,  $\text{C}_{10}\text{H}_{20}$ , and  $\text{C}_{12}\text{H}_{24}$ .

6. The complex of Claim 5 in which the peptide is selected from the group consisting of



COOH,



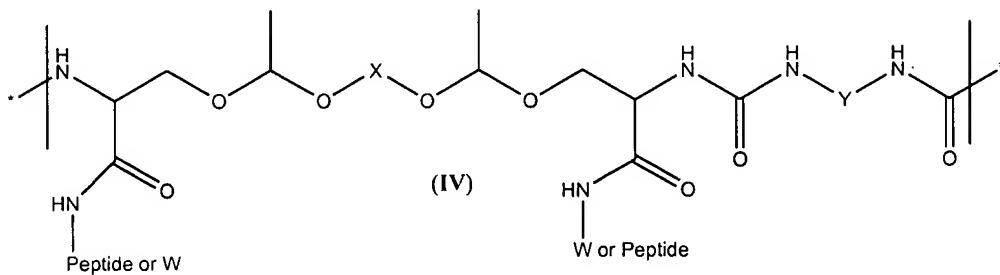
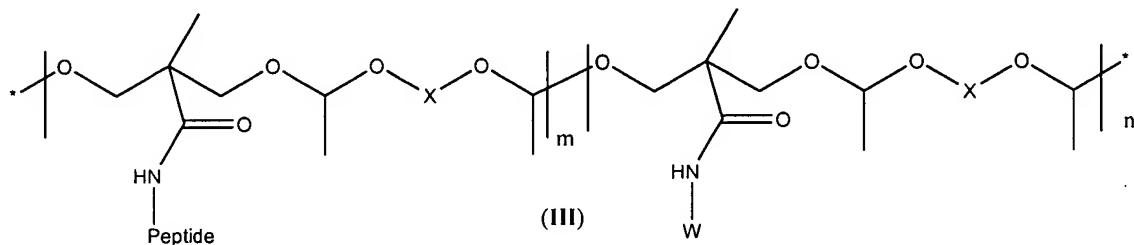
wherein X is selected from the group consisting of  $\text{CH}_2\text{CH}_2$ ,  $\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2$ ,

$\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2$ , and  $\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2\text{OCH}_2\text{CH}_2$ ; and

wherein Y is selected from the group consisting of linear or branched  $\text{C}_4\text{H}_8$ ,

$\text{C}_5\text{H}_{10}$ ,  $\text{C}_6\text{H}_{12}$ ,  $\text{C}_7\text{H}_{14}$ ,  $\text{C}_8\text{H}_{16}$ ,  $\text{C}_{10}\text{H}_{20}$ , and  $\text{C}_{12}\text{H}_{24}$ .

7. The complex of Claim 1 in which the biodegradable polyacetal-peptide comprises at least one recurring unit represented by a formula selected from the group consisting of (III) and (IV):



wherein the peptide is selected from any continuous combination of 2 to 45 amino acids with at least one or more arginine or lysine amino acids from 20 biological amino acids;

wherein X is selected from the group consisting of  $\text{CH}_2\text{CH}_2$ ,  $\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2$ ,  $\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2$ ,  $\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2\text{OCH}_2\text{CH}_2$ ;

wherein Y is selected from the group consisting of linear or branched  $\text{C}_4\text{H}_8$ ,  $\text{C}_5\text{H}_{10}$ ,  $\text{C}_6\text{H}_{12}$ ,  $\text{C}_7\text{H}_{14}$ ,  $\text{C}_8\text{H}_{16}$ ,  $\text{C}_{10}\text{H}_{20}$ , and  $\text{C}_{12}\text{H}_{24}$ ; and

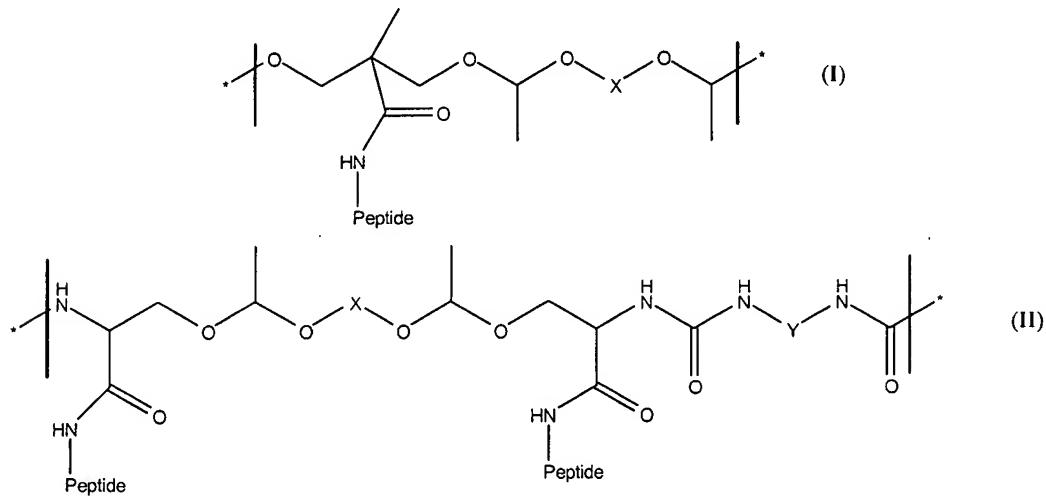
wherein W is a fatty acid moiety or a targeting ligand selected from the group consisting of galactose, lactose, mannose, transferrin, antibody fragment, and RGD peptide; and

m and n are positive integers.

8. A method of making the complex of Claim 1, comprising intermixing the polyacetal-peptide and the polynucleotide.
9. A method of making a complex for delivering a polynucleotide to a cell comprising intermixing a solution comprising the polyacetal-peptide of Claim 5 to a second solution comprising the polynucleotide.
10. A method for transfecting a cell, comprising contacting the cell with the complex of Claim 9.
11. A polyacetal-peptide represented by formula (I) or (II).
12. A method of cell transfection comprising the steps of:
  - (a) seeding cells to be transfected onto a solid support;
  - (b) mixing a polynucleotide for transfection with a polyacetal peptide;
  - (c) contacting the polynucleotide-polyacetal-peptide mixture with the seeded cells on the solid support; and
  - (d) incubating the solid support to allow transfection.
13. The method of claim 12, wherein a weight ratio of the polynucleotide to the polyacetal peptide is between about 1:4 and 1:50.

14. The method of claim 13, wherein the weight ratio of the polynucleotide to the polyacetal peptide is between about 1:16 and 1:32.

15. The method of claim 12, wherein the polyacetal peptide comprises at least one recurring unit represented by a formula selected from the group consisting of (I) and (II):

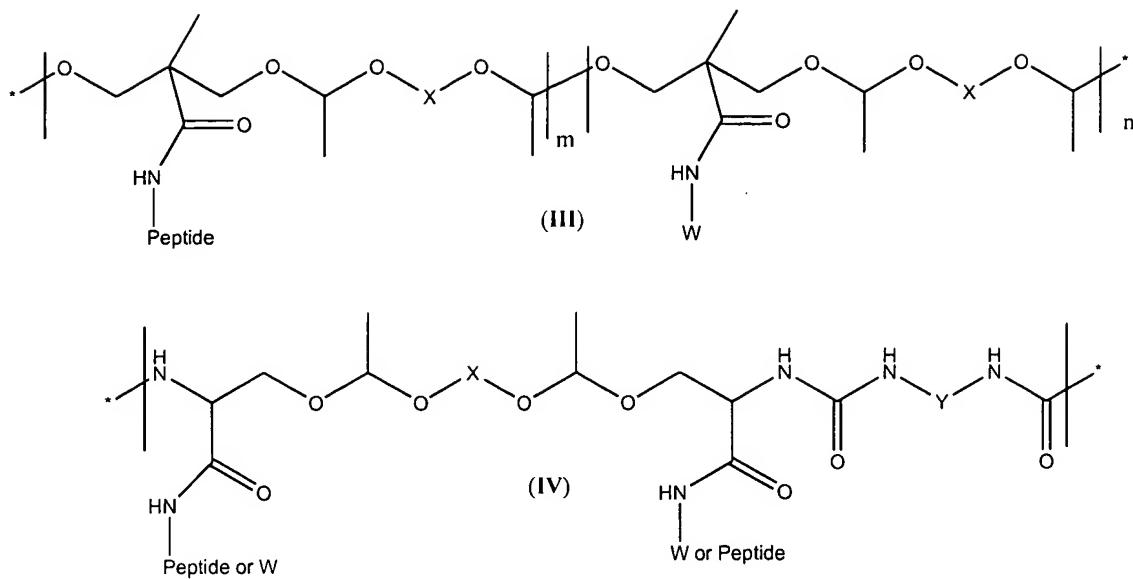


wherein the peptide is selected from any continuous combination of 2 to 45 amino acids with at least one or more arginine or lysine amino acids from 20 biological amino acids;

wherein X is selected from the group consisting of CH<sub>2</sub>CH<sub>2</sub>, CH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>, CH<sub>2</sub>CH<sub>2</sub>OCH<sub>2</sub>CH<sub>2</sub>, and CH<sub>2</sub>CH<sub>2</sub>OCH<sub>2</sub>CH<sub>2</sub>OCH<sub>2</sub>CH<sub>2</sub>; and

wherein Y is selected from the group consisting of linear or branched C<sub>4</sub>H<sub>8</sub>, C<sub>5</sub>H<sub>10</sub>, C<sub>6</sub>H<sub>12</sub>, C<sub>7</sub>H<sub>14</sub>, C<sub>8</sub>H<sub>16</sub>, C<sub>10</sub>H<sub>20</sub>, and C<sub>12</sub>H<sub>24</sub>.

16. The method of claim 12, wherein the polyacetal-peptide comprises at least one recurring unit represented by a formula selected from the group consisting of (III) and (IV):



wherein the peptide is selected from any continuous combination of 2 to 45 amino acids with at least one or more arginine or lysine from 20 biological amino acids;

wherein X is selected from the group consisting of  $\text{CH}_2\text{CH}_2$ ,  $\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2$ ,  $\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2$ , and  $\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2\text{OCH}_2\text{CH}_2$ ;

wherein Y is selected from the group consisting of linear or branched  $\text{C}_4\text{H}_8$ ,  $\text{C}_5\text{H}_{10}$ ,  $\text{C}_6\text{H}_{12}$ ,  $\text{C}_7\text{H}_{14}$ ,  $\text{C}_8\text{H}_{16}$ ,  $\text{C}_{10}\text{H}_{20}$ , and  $\text{C}_{12}\text{H}_{24}$ ;

wherein W is a fatty acid moiety or a targeting ligand selected from the group consisting of galactose, lactose, mannose, transferrin, antibody fragment, and RGD peptide;

and m and n are positive integers.

17. The method of claim 12, wherein the solid support is selected from the group consisting of a multiwell plate, a dish, a flask, a tube, a slide and an implanted device.
18. The method of claim 12, wherein the polynucleotide is selected from the group consisting of DNA, RNA, DNA/RNA hybrids and chemically modified nucleic acids.
19. The method of claim 18, wherein the RNA is single-stranded or double-stranded.
20. The method of claim 18, wherein the RNA is ribozyme or siRNA.
21. The method of claim 18, wherein the DNA is circular, linear or single-strand oligonucleotide.
22. The method of claim 12, wherein the cells are prokaryotic or eukaryotic cells.

23. The method of claim **22**, wherein the eukaryotic cells are yeast, plant or animal cells.
24. The method of claim **23**, wherein the animal cells are mammalian cells.
25. The method of claim **24**, wherein the mammalian cells are selected from the group consisting of hematopoietic cells, neuronal cells, pancreatic cells, hepatic cells, chondrocytes, osteocytes, and myocytes.
26. The method of claim **25**, wherein the neuronal cells are NT-2 cells.
27. The method of claim **12**, wherein the cells are fully differentiated cells or progenitor/stem cells.